

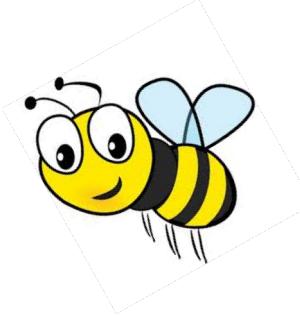


ML2 Honey Bee Images

Group 4

Ruyue Zhang, Phoebe Wu, Yijia Chen, Xiaochi Ge

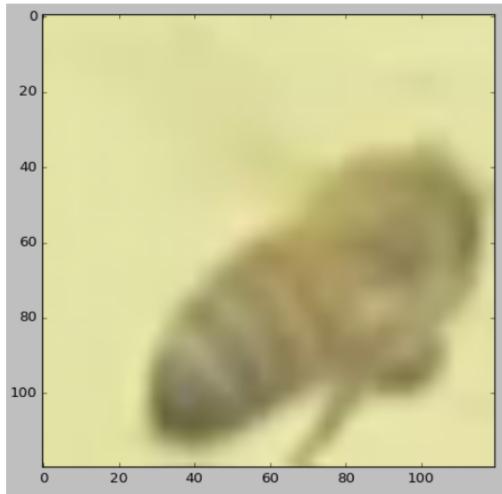
Introduction



- Dataset: The Bee Image Dataset
- columns:
 - file: 5172 images
 - date: 7/2/18 ~ 9/8/18
 - time: 8:20 ~ 21:13
 - location: 8 locations
 - zip code
 - subspecies: 7 subspecies
 - health: Hive health (healthy, few varroa hive beetles, ...)
 - pollen_carrying: true / false
 - caste: worker

Some Examples

- The pictures are extracted from still time-lapse videos
- Then each bee is cropped out to ensure each image has only one bee



Western honey bee
healthy

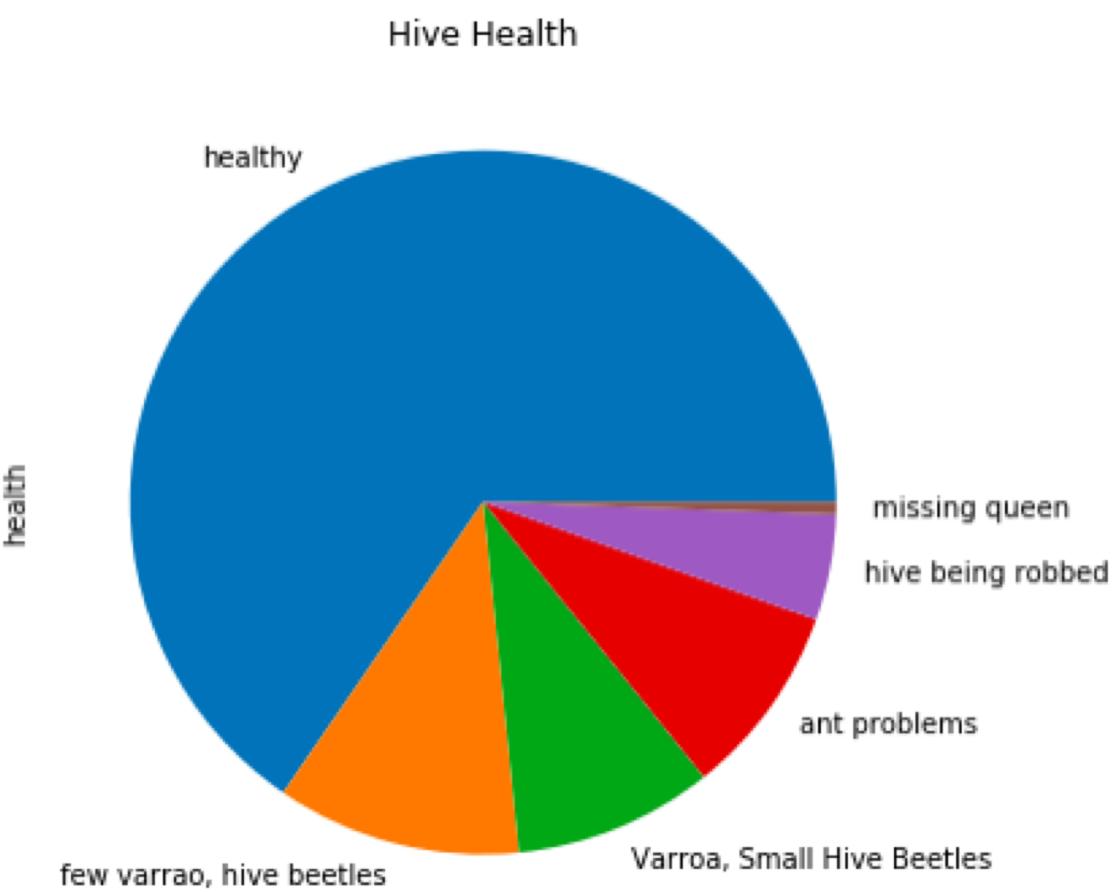
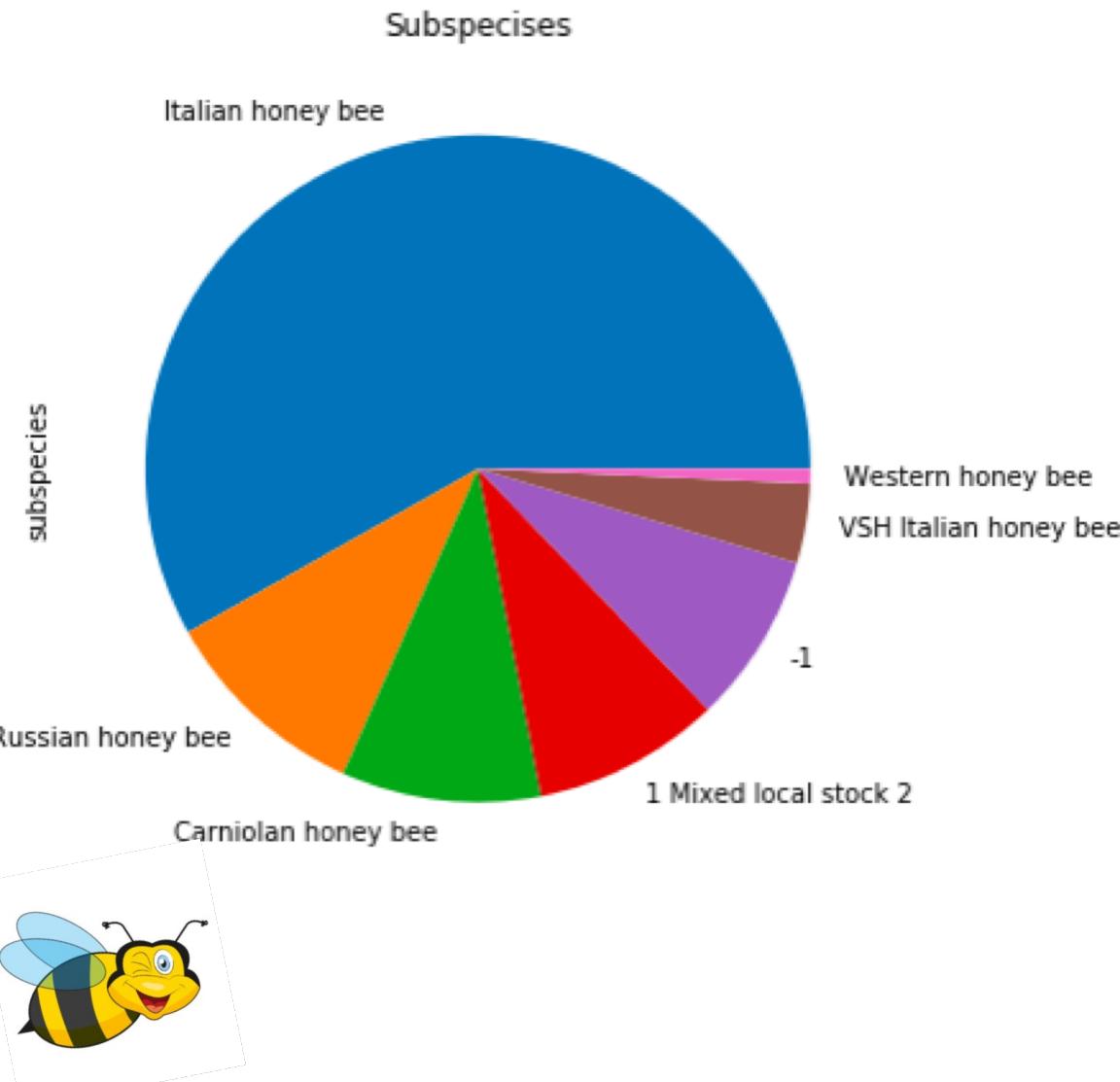


Italian honey bee
few varroa, hive beetles



Italian honey bee
healthy

EDA

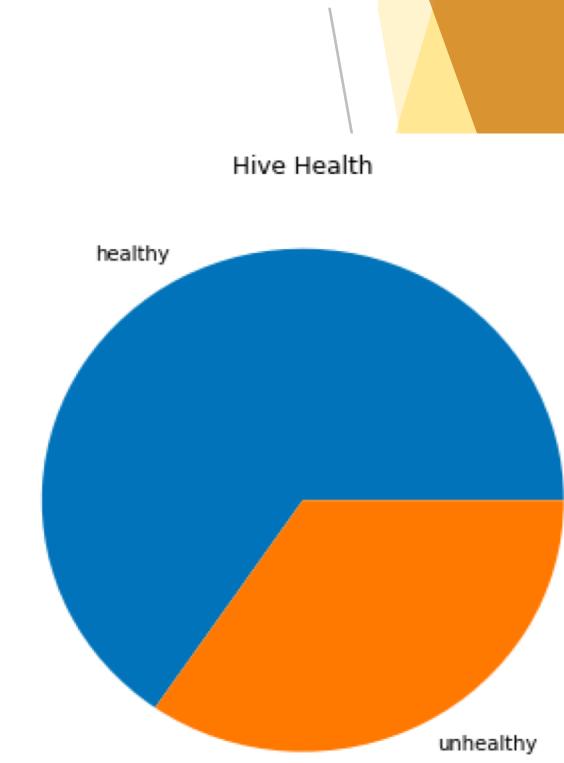




Preprocessing

- Subspecies
 - Convert classes to int.
 - Scale class strings to [0,1]
- Hive Health
 - change all unhealthy circumstances into ‘unhealthy’
- Train test split (70-30)
 - Train set: 3620 images
 - Test set: 1552 images

1 Mixed local stock	2	class 0
Western honey bee	1	class 1
Carniolan honey bee	2	class 2
VSH Italian honey bee	3	class 3
Italian honey bee	4	class 4
Russian honey bee	5	class 5
	-1	class 6



Subspecies Classification - Keras



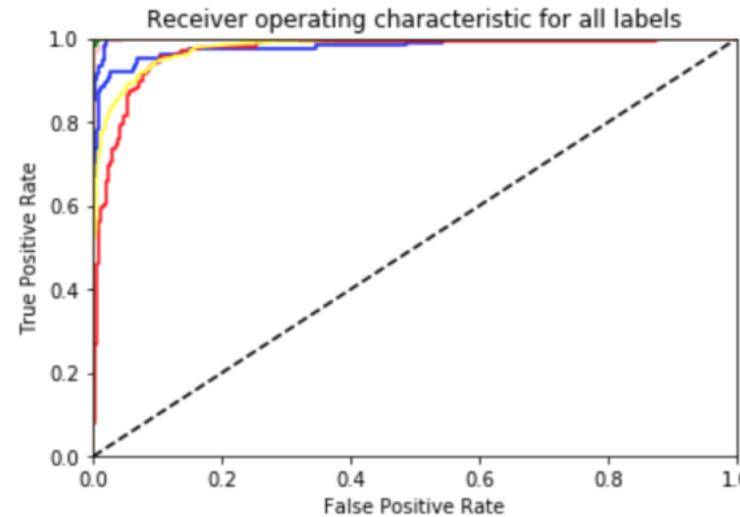
The focal loss

$$FL(p_t)$$

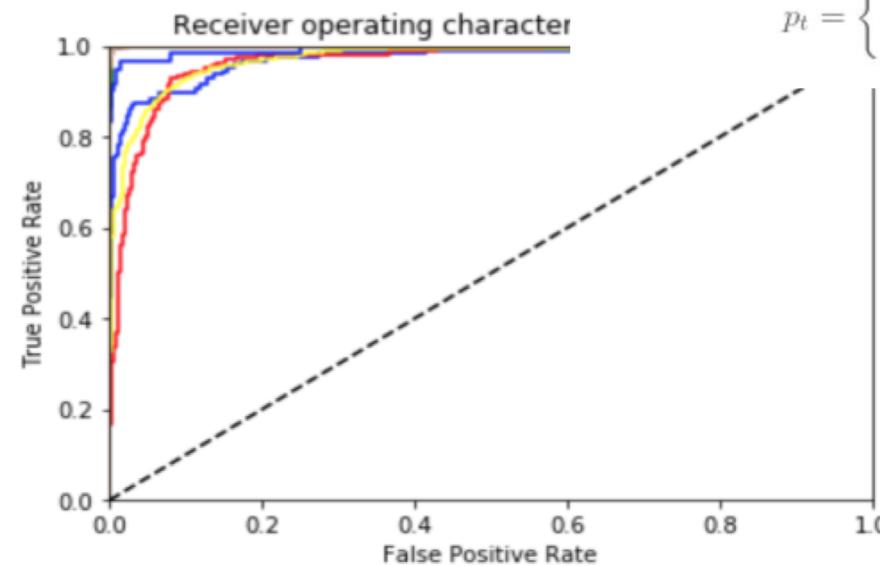
is defined as:

$$FL(p_t) = -\alpha \cdot (1 - p_t)^\gamma \log(p_t)$$

Model 43

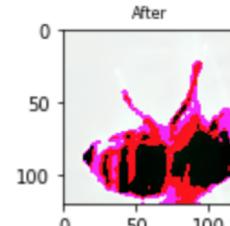
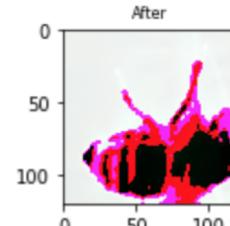
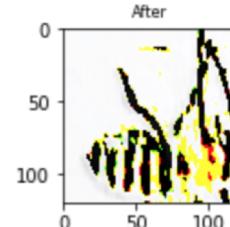
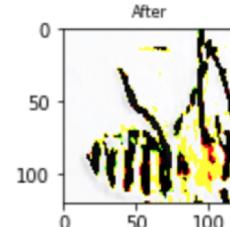
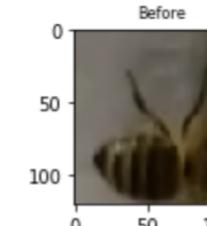
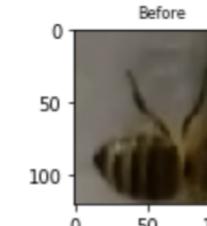
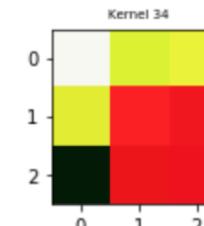
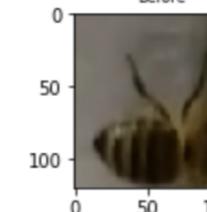
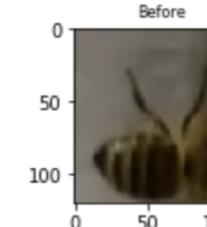
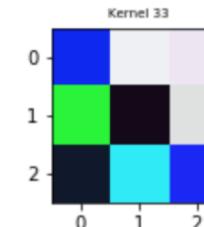
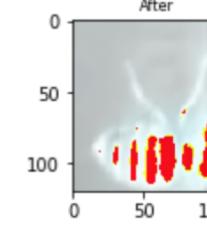
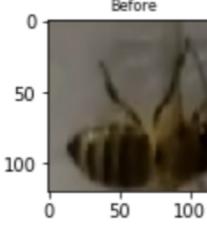
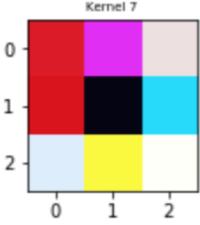
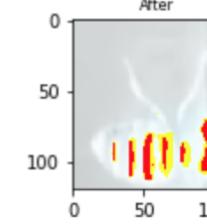
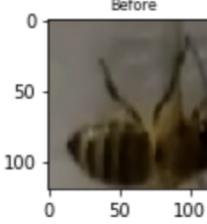
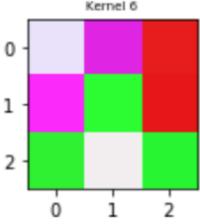
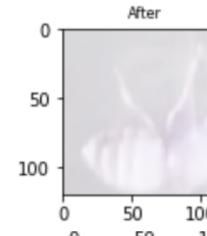
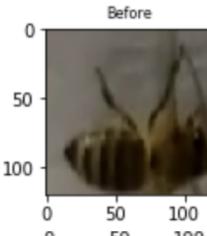
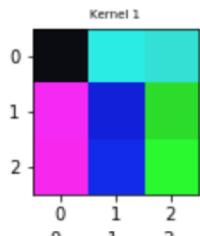
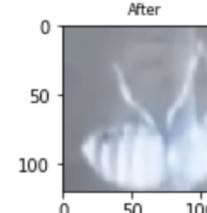
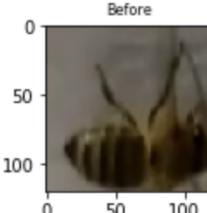
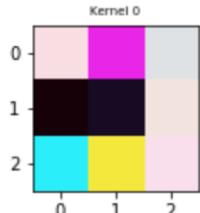


show_roc_auc(model43_f)

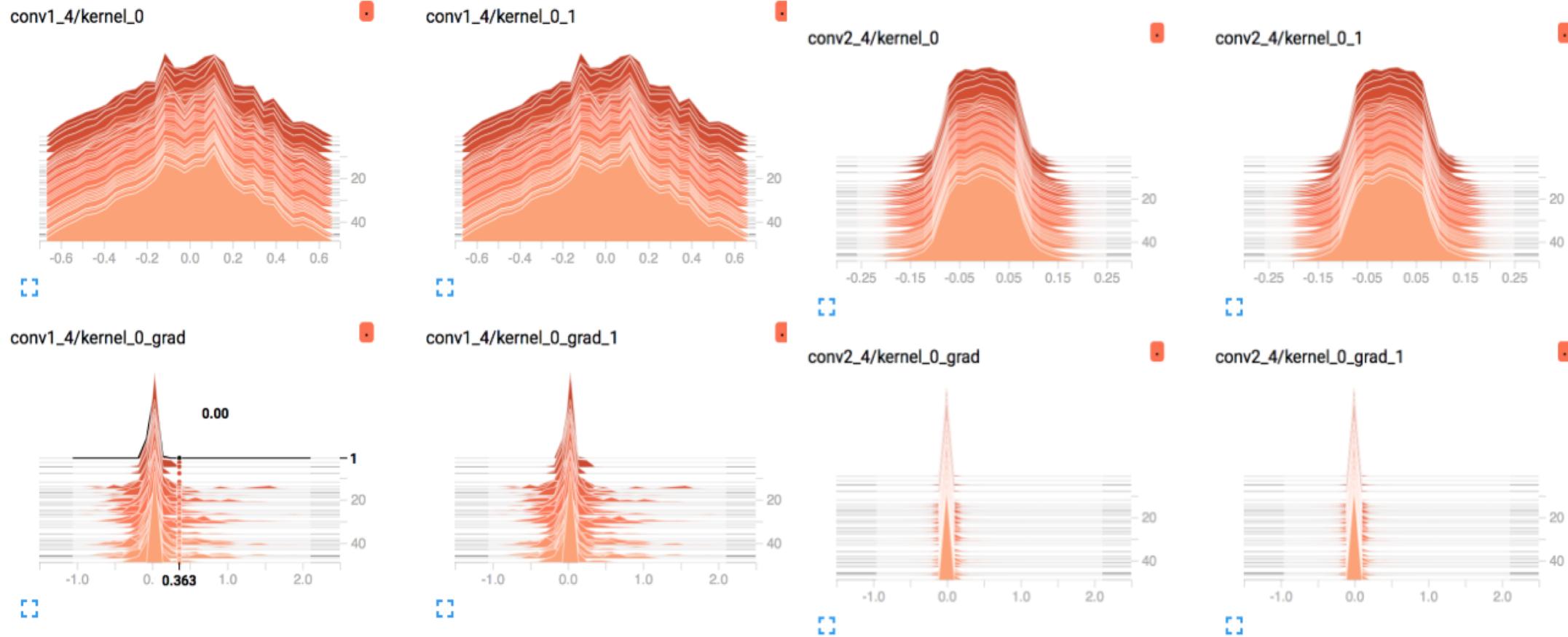


$$p_t = \begin{cases} p & \text{if } y = 1 \\ 1 - p & \text{otherwise,} \end{cases}$$

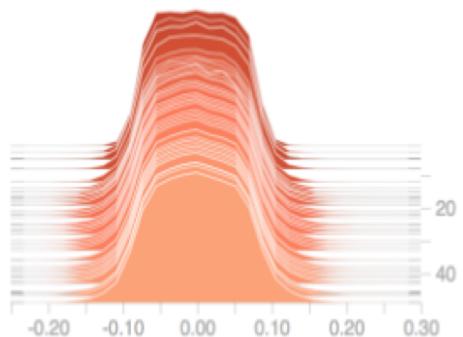
Kernel visualization



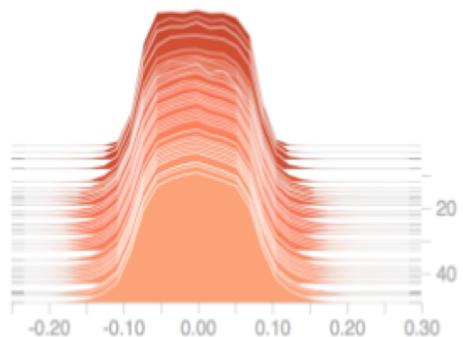
Tensorboard -- Weight



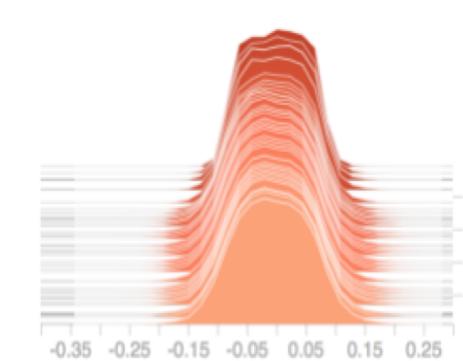
conv3/kernel_0



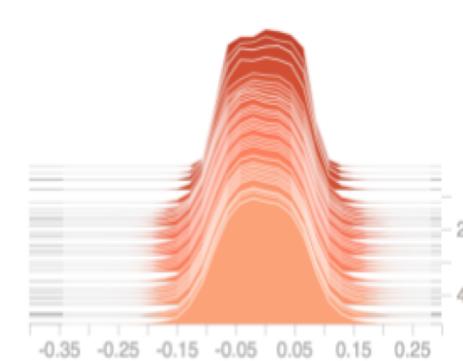
conv3/kernel_0_1



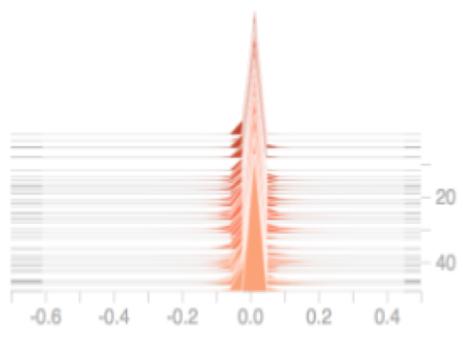
conv4/kernel_0



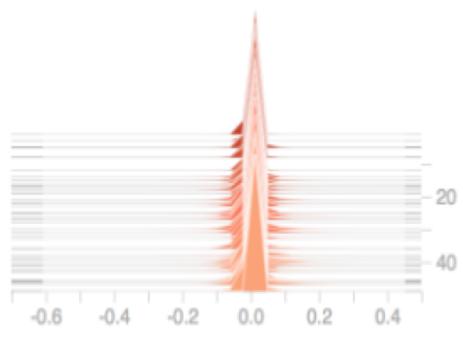
conv4/kernel_0_1



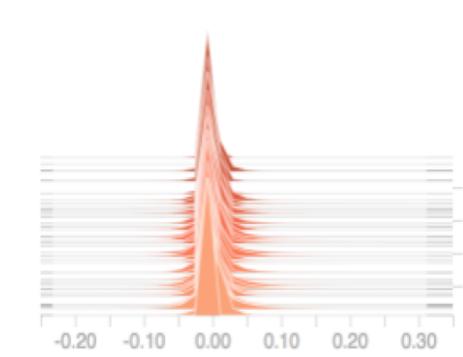
conv3/kernel_0_grad



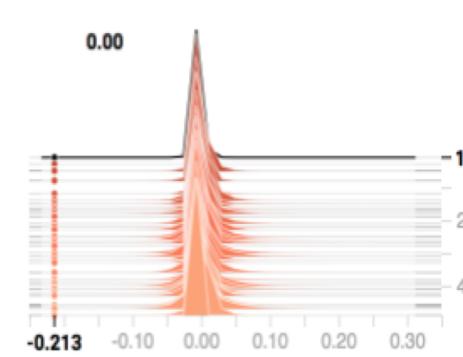
conv3/kernel_0_grad_1



conv4/kernel_0_grad



conv4/kernel_0_grad_1



Hive Health Classification - Keras

- Without Batch Normalization (Epochs = 30)|

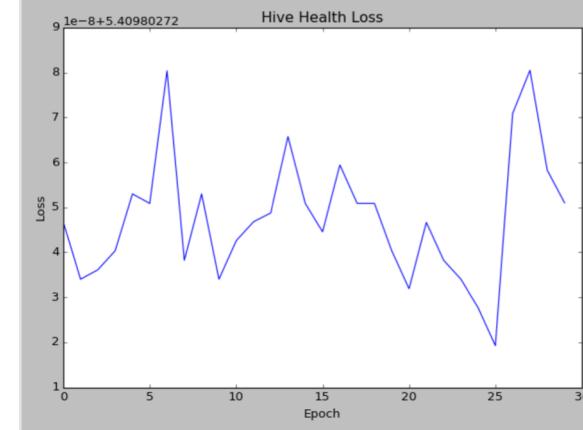
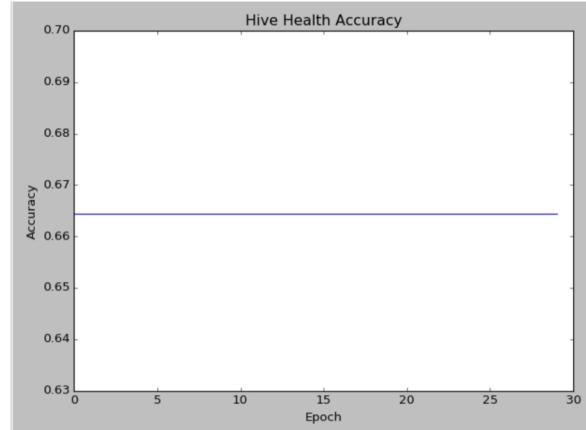
	Training 1(Test Accuracy)	Training 2(Test Accuracy)
Batch Size = 32	0.995	0.992
Batch Size = 64	0.989	0.987

- With Batch Normalization (Epochs = 30)|

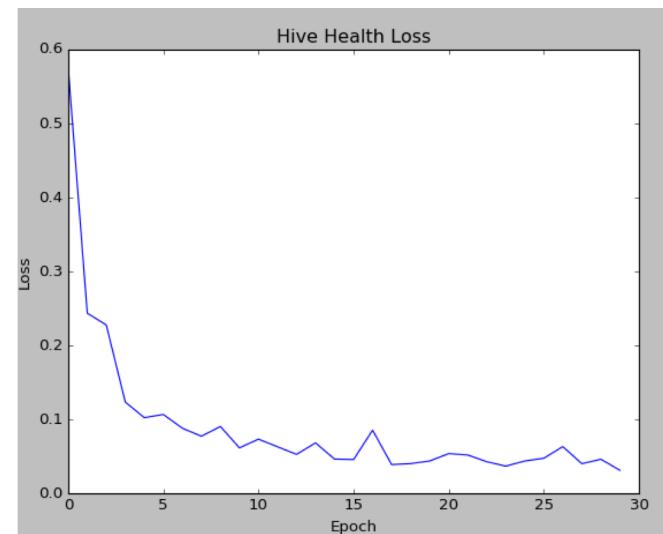
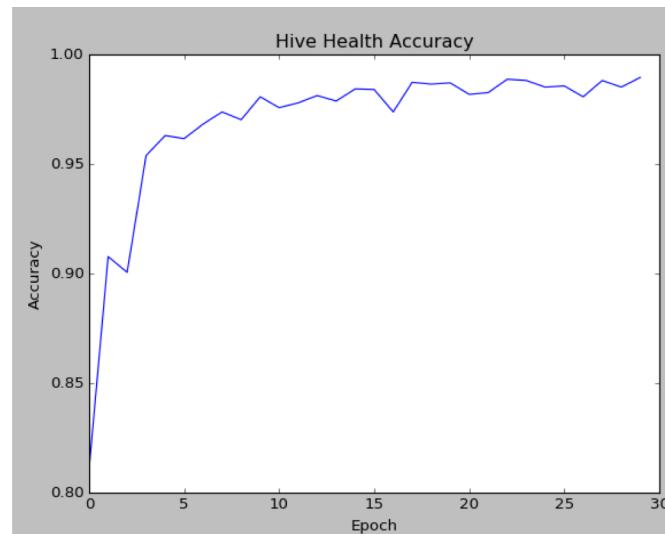
	Training 1(Test Accuracy)	Training 2(Test Accuracy)
Batch Size = 32	0.631	0.631
Batch Size = 64	0.631	0.631



Hive Health Classification - Keras



	precision	recall	f1-score	support
healthy	0.63	1.00	0.77	979
unhealthy	0.00	0.00	0.00	573
avg / total	0.40	0.63	0.49	1552
	precision	recall	f1-score	support
healthy	0.99	0.99	0.99	979
unhealthy	0.99	0.99	0.99	573
avg / total	0.99	0.99	0.99	1552

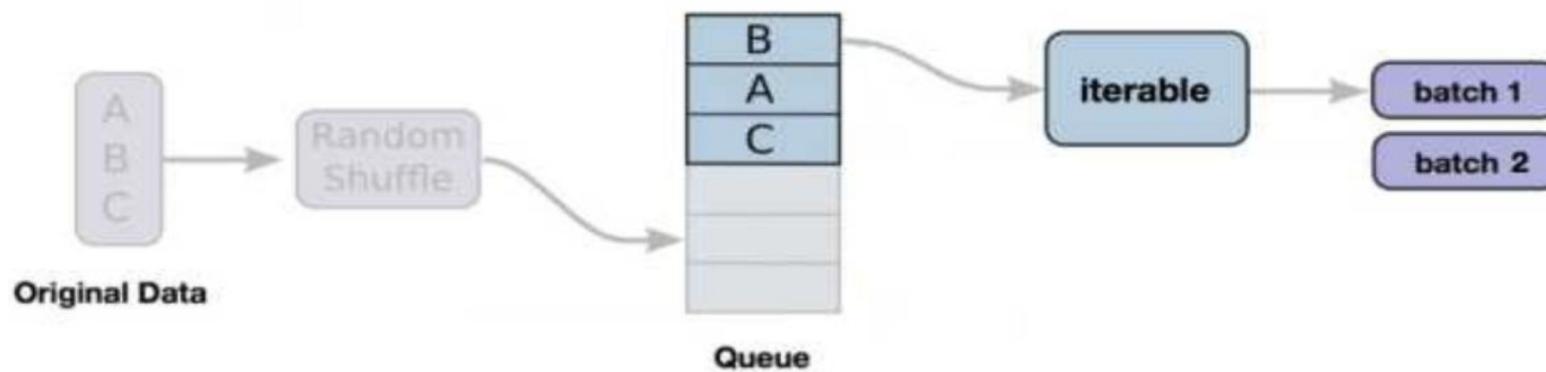


Training 2 Accuracy
and Loss
Batch Size = 32,
Epochs = 30



Pytorch

DataLoader



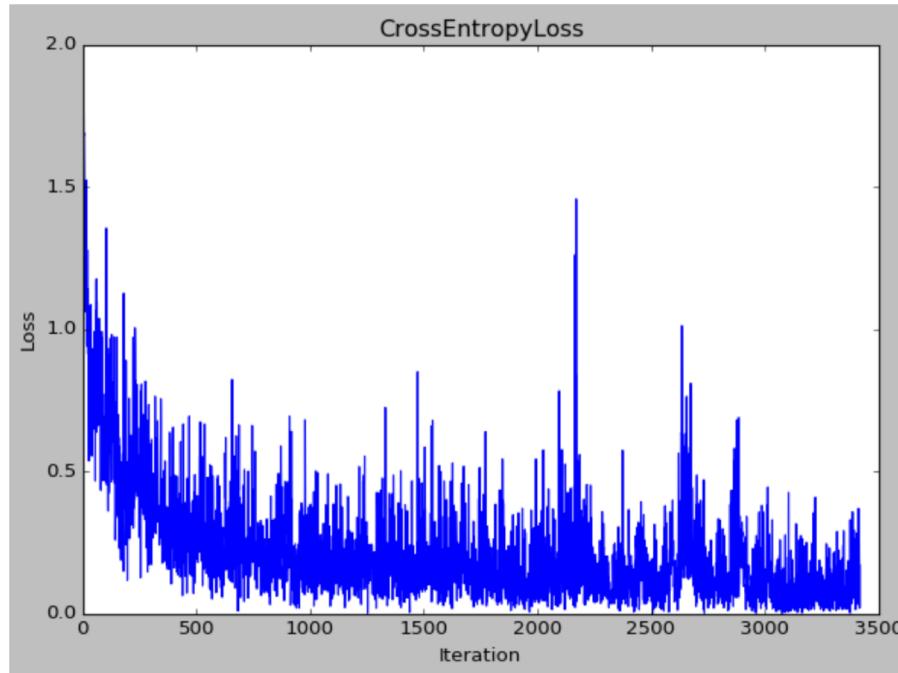
```
output_size = (in_size - kernel_size + 2*(padding) / stride) + 1
```



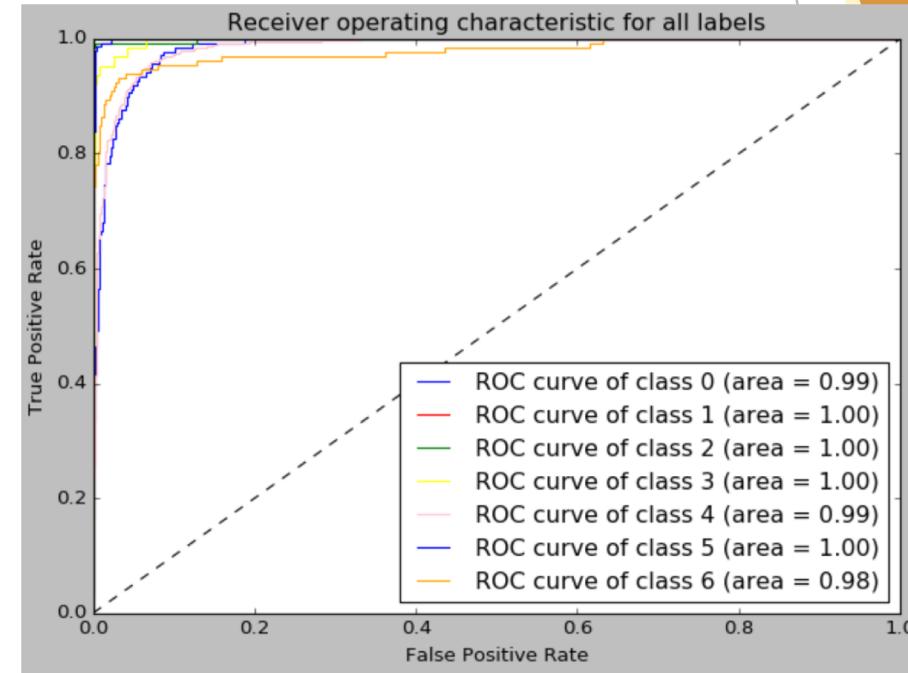
Subspecies Classification - PyTorch



Training Loss



ROC curve

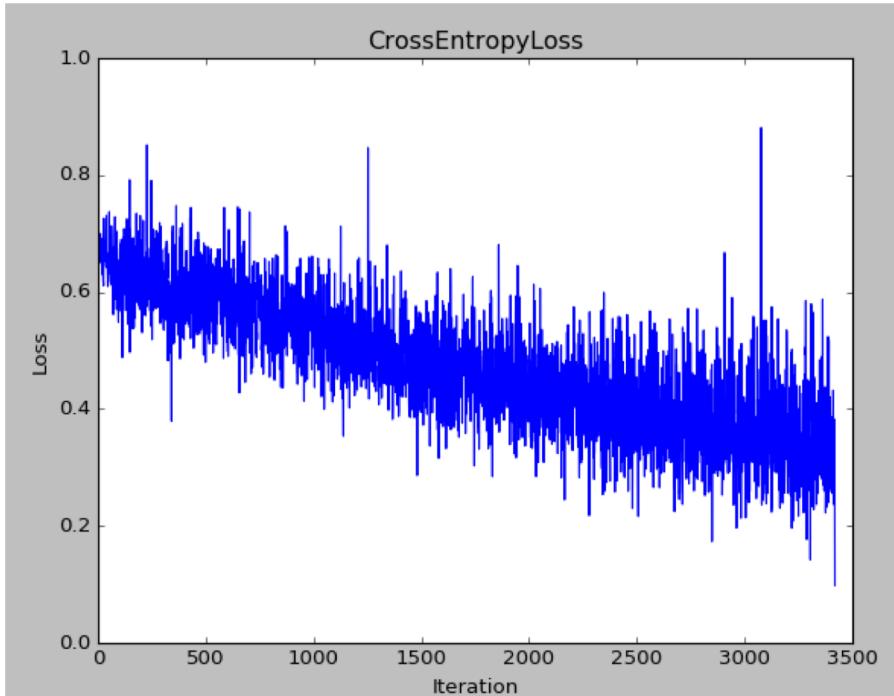


Classification Report

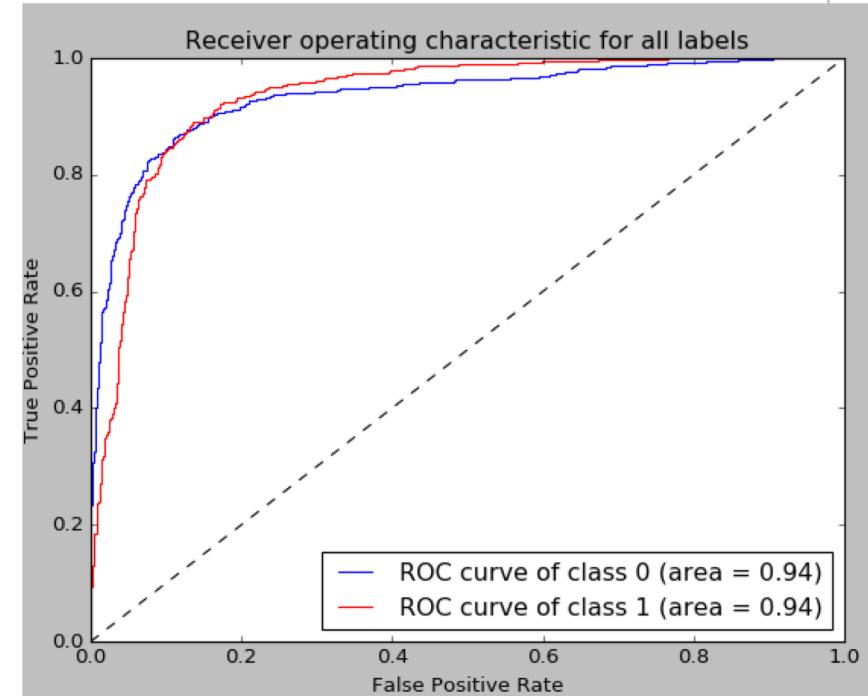
	precision	recall	f1-score	support
1 Mixed local stock	0.63	0.92	0.74	138
2 Western honey bee	0.75	1.00	0.86	6
Carniolan honey bee	0.93	0.99	0.96	142
VSH Italian honey bee	0.86	0.95	0.90	64
Italian honey bee	0.97	0.89	0.93	914
Russian honey bee	0.89	0.99	0.94	155
-1	0.97	0.76	0.85	133
avg / total	0.92	0.91	0.91	1552

Hive Health Classification - PyTorch

Training Loss



ROC Curve



Classification Report

```
('Computational Time:', 198.369313955307)
Test Accuracy of the model on the 1552 test images: 87 %
precision    recall    f1-score   support
```

	precision	recall	f1-score	support
healthy	0.89	0.94	0.91	1035
unhealthy	0.85	0.76	0.80	517
avg / total	0.88	0.88	0.87	1552



Conclusion



- Subspecies F1 score: 0.93
- Hive Health F1 score: 0.99

- For future research, we could use more layers and change pooling methods.
- Collecting more images in the dataset to fix the imbalanced problem, we would have a better accuracy on some of the bee classes.

Thank you

